INTERIM GUIDELINES FOR THE PRODUCTION AND USE OF AEROBIC COMPOST IN ONTARIO

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INTERIM GUIDELINES FOR THE PRODUCTION AND USE OF AEROBIC COMPOST IN ONTARIO

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PREFACE

Natural biological decay of waste or dead plant and animal life has been a feature of the environment since the first emergence of life. In the early years of this century, engineers learned to use these natural reactions to provide inexpensive, safe and efficient methods of treating waste.

These developments led to widespread use of the activated sludge process for treatment of municipal and industrial liquid waste streams. In addition, aerobic and anaerobic digestion processes, are common features in water-pollution control plants, for stabilizing sludge. The biological processes, and the equipment and design parameters required for their control and optimization, are well understood as evidenced by the wealth of scientific and engineering literature available.

Aerobic composting and anaerobic digestion or composting of sludges and solid wastes are variations of the above processes, where the same goal of reducing complex organic matter into simpler, more stable compounds is sought by using micro-organisms. Composting requires its own design parameters, operating methods and equipment to provide the optimum environment for biological degradation of waste.

Composting is also a well researched, well understood process among scientists and engineers. It is not, however, as well understood at the operational level. This is mainly because, until relatively recent times, landfilling wastes was more expedient than other means of waste management, including composting. With the advent of "garbage crises" in North America however, allied with increased awareness and concern regarding the long-term effects of landfilling, there has been renewed interest in alternatives to landfilling.

Ontario has begun to implement the 3Rs principles (*Reduction, Reuse, Recycling*) to improve waste management and meet current and future needs. The 3Rs apply to both municipal and industrial wastes and are already succeeding in diverting wastes from disposal. The provincial government's goal is to divert at least 50% of wastes from disposal by the year 2000.

There will be a continuing need to provide alternative waste management methods for materials not readily amenable to 3Rs initiatives. Some disposal will still be required, but composting will likely be attractive for treating biodegradable solid organic wastes. Thus, composting is currently experiencing "re-discovery" and will likely see wider use in the near future.

While this is a welcome development, caution must be exercised. Seemingly simple on the surface, composting is a complex process which requires considerable knowledge and skill for success. In the past, many operations have failed due to inappropriate application of the process, poor design, improper equipment selection, poor location of plants, or for other reasons. The few bad operations caused potentially good operations to be dismissed as

having the same problems.

For example, there was considerable interest in composting during the 50's and 60's but this had faded by the late 60's. This was due to bad experiences with poorly engineered and operated facilities for which overly optimistic expectations and claims were made. In addition, the failure to develop markets compounded problems and caused financial problems.

Thus, composting requires a rational engineering approach and each system must be based on and developed using well defined engineering design, operation, monitoring and analytical principles. The use of the compost product similarly requires a careful approach with due regard to the sensitivities of the specific application.

It is vital, therefore, that both public and private sector waste management organizations and interests recognize this, and approach composting as a waste management alternative in a rational, realistic manner.

Summary

The *Interim Guidelines for the Production and Use of Aerobic Compost in Ontario* has been prepared to assist composting proponents, ministry staff and staff of other agencies in the selection and/or approval of appropriate aerobic composting methods and the production of quality compost based on good operating practices, compost characteristics, and current Ministry of the Environment legislation.

The *Interim Guidelines* are derived from previous ministry guidelines developed for other purposes, experience gained by the ministry from its own composting operations, discussions with compost operators in Ontario and elsewhere, review of other agencies' requirements, and an in-depth review of the literature.

It provides a review of regulatory requirements for aerobic composting and a brief overview of the process, highlighting parameters critical to the success of composting.

The information will aid in the attainment of high quality compost product. Value added markets for the product may require development, but offer the best long-term potential for rendering the process economically viable.

It is recommended that proponents discuss project proposals with Ministry of the Environment staff as an initial step to obtain regulatory and technical advice. Also, public meetings and consultation with neighbours of the proposed site will assist in avoiding potential problems and delays.

It is noted that in time, the compost quality requirements may be updated as better

information becomes available.

The *Interim Guidelines* should be used along with good judgement and past practical experience in the handling of compostable wastes, their biodegradation, and marketing of product. While this guide includes discussion of measures for the protection of the environment and human health, specific market applications may require more stringent quality specifications. Moreover, it is not intended to provide detailed specifications for all markets but distinguishes between composted material as a *product*, that may have many uses, or as a *waste*, and that must be managed as such.

Furthermore, the *Interim Guidelines* are not intended to restrict process or equipment development. For highly modified composting techniques or new or updated technology differing significantly from currently accepted practices and processes, the proponent should demonstrate that the technology is consistent with the overall intent of the *Interim Guidelines*.

1.0 PURPOSE

The purpose of the *Interim Guidelines for the Production and Use of Aerobic Compost in Ontario* is to provide environmental and human health protection while permitting compost production and use.

2.0 OBJECTIVE

The objective of the *Interim Guidelines* is to ensure that composting projects and compost use are managed with due regard to process conditions and chemical and physical characteristics, to prevent contamination of the environment. Ultimately it is hoped that the guidelines will help to ensure that composting is allowed to develop as a significant waste management option to contribute to Ontario's waste diversion objectives.

In addition, the *Interim Guidelines* is a reference document to ensure that the approval of systems for the production, handling and use of compost, is managed in a consistent manner throughout Ontario. However, it is also subject to periodic revisions as new information becomes available.

3.0 SCOPE

The guidelines in this document do not apply to backyard composting by householders.

Composting is defined as an aerobic biological process, conducted under controlled, engineered conditions designed to decompose and stabilize the organic fraction of solid waste.

Compost is defined as the material produced by an aerobic composting process, which can be used as soil amendment, or for other similar uses. Simple exposure of solid organic waste under non-engineered conditions resulting in uncontrolled decay is not considered to be composting and will not be permitted.

Anaerobic digestion or composting, is not included in the guidelines but all contaminant concentrations will also apply to anaerobic systems. Operating conditions will be considered on a case-by-case basis.

This document includes discussion of *generic composting technologies*, major operating parameters, and sampling and chemical analyses. Reporting of results,

monitoring of processes, and assessment of potential off-site impacts are also included.

Relevant legislation and standards are referenced in Section 4.0.

Agricultural wastes, as defined in Regulation 309, are exempt from Part V of the *Environmental Protection Act*, and thus are not subject to the guidelines.

Process operating parameters and chemical and physical quality for compost use are provided.

Quality requirements for specific market applications may be more stringent than indicated in this guidelines document. Many of these specific markets (e.g. nurseries) have established their own quality specifications for materials they purchase or use.

4.0 APPROVALS AND PERMITS

4.1 Approvals

The following are the main provincial statutes which apply to composting operations:

- *The Environmental Assessment Act*, (EAA)
- *The Environmental Protection Act*, (EPA)
- *The Ontario Water Resources Act* (OWRA)
- *The Consolidated Hearings Act*, 1981

Proponents should also be aware of the potential application of the *Ontario Municipal Board Act*, the *Planning Act*, the *Expropriations Act*, the *Conservation Authorities Act* and the federal *Fertilizers Act* to composting projects.

4.2 *Environmental Assessment Act* (EAA)

The *Environmental Assessment Act* applies to provincial and municipal projects and may also apply to private sector projects at the Minister of the Environment's discretion. The threshold level for the application of the EAA to composting facilities is a capability for 200 or more tonnes per day of residual waste (i.e. materials that would require disposal) generation from the facility. If the Minister deems the site to be environmentally significant, the site may require an environmental assessment, irrespective of the 200 tonnes per day threshold.

For further information on the EAA process, staff of the ministry's Environmental Approvals and Environmental Assessment Branches should be consulted.

4.3 *Environmental Protection Act* (EPA)

4.3.1 General

Part V of the *Environmental Protection Act* and Ontario Regulation 309 govern the disposal and processing of wastes at waste disposal sites for which Certificates of Approval are required.

A composting site is defined as a *Waste Disposal Site (Processing)*; (Form 1645/80). A composting site, however, is not a *final* disposal site. Hearings are therefore not mandatory under the EPA, but discretionary hearings are held when the Director of the Approvals Branch considers them necessary. Ministry of the Environment policy 14-01, *Guidelines for Hearings on Waste Disposal Sites*, describes when hearings are either mandatory or discretionary.

Composting processing areas should be separated from other land use zones by buffer zones, which should be included as part of the project.

Waste Management Systems Certificates of Approval are required for handling all waste materials, including those used for compost production, from their sources (generators) to the composting facility.

Where leachate is recirculated back to the composting material, this practice must be included in the application for Part V approval under the EPA.

If the composting site obtains all ministry approvals and the material from the composting process *meets the Interim Guidelines requirements*, the compost will be deemed to be a ***product***. In this case, approvals for sites where the product is used and for its transportation are exempted from Part V of the EPA.

If, however, the material from the composting process *fails to meet the Interim Guidelines requirements*, it will be considered a ***waste*** under Regulation 309. The ministry will require systems approvals for transportation of this waste.

The composting proponent will also require a Certificate of Approval (Air) under Section 8 of the *Environmental Protection Act* (Form 1147 4/76). Regulation 308, the general air management regulation sets standards for acceptable levels of airborne emissions (stack or fugitive), noise, and odour. Applicants should consult with ministry regional staff.

4.3.2 On-site Composting

All composting sites processing materials generated at the site, as is sometimes the case at correctional facilities and hospitals, do not require approval under Part V of the EPA. Material from the composting process must comply with the *Interim Guidelines* as described in Section 4.3.1.

4.4 *Ontario Water Resources Act* (OWRA)

Approval under Section 24 of the *Ontario Water Resources Act* for the works discharging waters to a receiving water body or direct to ground will be required. Ministry of the Environment regional staff should be consulted.

4.5 *The Consolidated Hearings Act*, 1981

If a project is subject to two or more hearings before more than one tribunal under statutes listed in the *Consolidated Hearings Act, 1981*, and has been planned such that the issues can be considered in a common forum, the proponent may wish to use the mechanisms of the *Consolidated Hearings Act*, to avoid more than one hearing.

4.6 Applications for Approval of Composting Sites

Applications should be sent to the nearest Ministry of the Environment District Office for review. In addition, comments should be solicited by the proponent from the local Medical Officer of Health and the Ministry of Labour, to ensure that the health and safety of the operators and the public are adequately protected.

4.7 "Permit by Rule"

"Permit by rule," as it is known in some jurisdictions, helps to simplify the approval process. Its application to material recycling sites is expected to become regulation in early 1992 (see *Initiatives Paper No. 1: Regulatory Measures to Achieve Ontario's Waste Reduction Targets*). Certain types of composting projects, for example, leaf and yard waste composting sites, will be exempted from the full EPA Part V Approvals process provided they comply with the conditions demonstrating compliance with a set of standards to the satisfaction of the Ministry.

5.0 SITING

Proponents should consult staff in the nearest Ministry of the Environment District Office to ensure and confirm that they are using most current siting and land use policies. Such information as well as maps and plant operating information will be required. Examples of this are shown in Appendix 2.

5.1 Buffer Zones

Composting facilities, including all buildings, processing and storage areas and access roads, should provide a minimum separation distance of 100 metres from the property line of the nearest residence, school, place of worship, hospital or other public institution.

Facilities should also be spaced a minimum of 100 metres from any water well or water body.

Required distances from sensitive land uses and any area of residential development should be determined by consultation with staff in the nearest Ministry of the Environment District Office.

6.0 COMPOSTING OPERATING REQUIREMENTS

For ideal process conditions, a optimum thermophilic temperature range between 55°C and 60°C throughout the composting material should be maintained.

6.1 Pathogen Reduction

Ideally, in the high rate stage of composting, the temperature should be maintained in the optimal range between 55°C and 60°C to provide for both bacterial growth and pathogen inactivation. A minimum temperature of 55°C must be maintained to comply with this guideline.

6.1.1 Windrow and Static Pile Composting

To inactivate pathogens, material throughout the pile must be maintained at a temperature of at least 55°C for at least fifteen (15) days during the composting process. Windrows must be turned over at least five (5) times during the composting period to subject all material to the minimum 55°C temperature. This 15 day period is not necessarily consecutive but must be cumulative. This is defined as the period of

pathogen inactivation. Static piles, which are not turned, must meet the same temperature requirement, again throughout the pile. The pile may be covered with an insulating layer of material such as cured compost or wood chips to ensure that all areas of the feed material are exposed to the required temperature.

6.1.2 In-Vessel (Mechanically Mixed and Aerated) Composting

A minimum 3 day retention time at a temperature of at least 55° C is required. This is defined as the period of pathogen inactivation. The lower time requirement recognizes the better reliability of in-vessel systems with respect to mixing and process control.

If temperature monitoring shows the above has not been achieved, the material from the composting process must be disposed or re-processed.

6.2 Temperature

Temperatures must be measured at least one metre inside the pile at points sufficient to provide a temperature profile of the composting material.

For batch windrow and static pile systems, temperatures must be recorded daily during the period of pathogen inactivation, then weekly until the processing ends.

For continuous feed systems, daily temperature monitoring is required. Batch in-vessel systems require daily temperature monitoring for the entire retention period.

6.3 Oxygen Requirements

Oxygen levels should be maintained above 10% (by volume) and normally are controlled in the 12% to 18% range. It is noted that different wastes may have different oxygen requirements and that aeration intensity may be altered to suit. Oxygen levels in forced aeration composting systems, for example, in-vessel and static piles, should be monitored and controlled. In mechanically mixed composting systems, for example, windrows, lower oxygen levels may be experienced depending on turning frequency; turning frequencies must be selected commensurate with avoidance of nuisance conditions (odour).

6.4 General

In the case of windrow or static pile processes the operator shall ensure:

- That the rows or piles are physically sized to be manageable by the proposed equipment; and
- That the windrows or piles are arranged to permit vehicle access to the composting and storage areas.

7.0 COMPOST QUALITY

7.1 Introduction

The specifications in 7.2, 7.3, 7.4 and 7.5 must be met by the final product in the form it leaves the composting site, if the compost is to be used on an unrestricted basis.

Material from the composting process that fails to meet the guideline will be deemed to be a ***waste*** under Regulation 309. It is expected that operators of composting sites will make every effort to accept only those feed materials for the composting process that will ensure that the output will meet the Guideline criteria.

Quality requirements for specific market applications (e.g. pH and salinity for some plants, particle size) may be more stringent than indicated in this Guideline.

7.2 Metals

The metal content of the finished compost will not exceed the following concentrations as calculated on a dry weight basis:

Metal	Concentration (mg/kg dry wt)
Arsenic	10
Cadmium	3
Chromium	50
Cobalt	25
Copper	60
Lead	150

Metal	Concentration (mg/kg dry wt)
Mercury	0.15
Molybdenum	2
Nickel	60
Selenium	2
Zinc	500

To prevent dilution of contaminated feed materials, no individual waste source, additive, or inoculant may exceed the metal concentration limits.

The compost quality metals standards are identical to concentrations for rural soil contained in the Ministry of the Environment's *"Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples*. This information on typical background levels in Ontario soils is currently being updated by the ministry. The metal concentrations may be modified when updated data are available.

7.3 Organic Chemicals

The organic chemical content of the compost shall not exceed the following concentrations as calculated on a dry weight basis:

Chemical	Concentrations (mg/kg dry wt)
PCB	0.5

PCB concentration is taken from the Canadian Council of Ministers of the Environment guidelines for agricultural soils.

Other organic chemicals will be included as relevant criteria are developed.

7.4 Non-Biodegradable Particulate Matter

The finished compost must contain no material of a size or shape that reasonably can cause human or animal injury, or damage to equipment.

The non-biodegradable particulate content of the compost greater than 8 mesh screen size shall not exceed the following:

Parameter	Concentration (% dry wt)
Plastic	1.0
Other (total)	2.0

7.5 Stability

Various means for determining stability are suggested in Appendix 3. Any of the methods alone or in combination may be used. If no determination of stability is made, the compost must be cured for a six month period.

7.6 Other Parameters

These are not specifications, but are ranges of characteristics typical of good compost quality:

7.6.1 Compost Particle Size

< 25 mm

7.6.2 Mineral Content

Parameter	Typical Minimum Concentrations (% dry wt)
Total Nitrogen	0.6
Total Phosphorus	0.25
Total Potassium	0.20
Calcium	3.0
Magnesium	0.3

7.6.3 Typical Organic Matter Content

> 30% on a dry weight basis

7.6.4 Typical Carbon:Nitrogen (C/N) Ratio

22

7.6.5 Salinity (chloride, fluoride, sulphate)

Total Salts (milliSiemens/cm) - < 3.5
Sodium Absorption Ratio (SAR) - < 5

7.6.6 pH

5.5 - 8.5

7.6.7 Moisture Content

Commensurate with end-use: typically 30% - 55%

7.6.8 Water Holding Capacity

Typically 3 times dry weight

7.7 Organic Matter Reduction

No single number can describe satisfactory organic matter reduction, as reduction is proportional to the organic content of the raw feed. The per cent reduction in organic content will be measured by loss on ignition solids analyses and calculated by the expression:

$$100\left(1-\left(\frac{(\%\text{ ash in Raw} \times \%\text{ VS in Treated})}{(\%\text{VS in Raw} \times \%\text{ ash in Treated})}\right)\right)$$

where: VS = Volatile Solids
Raw = Raw feed
Treated = Compost product

8.0 MONITORING

8.1 Introduction

To ensure that the composting operation maintains the ongoing quality needed, periodic analysis, monitoring and reporting is required. Monitoring should be designed and implemented to ensure a safe and environmentally sound operation that produces a consistent and high quality compost.

The facility operator must retain proof that the compost meets all quality parameters.

The specific sampling and analysis program must be included in the application for approval of the site.

Operating and production records must be kept two years past the disposition of the compost, and must be made available to the Ministry on request, and summarized in an annual report submitted to the Regional Director.

8.2 Sampling

8.2.1 Sample Size

Grab samples, each a minimum of 100 kilograms, will be taken and composited as shown below, for subsequent chemical analyses. The grab samples will be taken at uniform intervals throughout the working day for continuous processes or from diverse points in the batch (1 metre into the pile from the surface of the pile). Analytical samples will be prepared from the composited grab samples.

Volume of Feed or Composting Material (cubic meters)	Number of Grab Samples Required
10	4
15	5
25	6
35	7
50	8
70	9
100 or more	10

8.2.2 Sampling Frequency

- *Feed Material*: When raw feed material quality appears relatively constant, sampling and analysis should be done weekly during the first month. Subsequently, sampling may be done once every two months if consistency is demonstrated.

- *Finished Compost*: A composite sample of the compost will be analyzed for guideline compliance every two months or every 5,000 tonnes of compost, whichever comes first. Sampling may be reduced to once every four months if compost quality is demonstrated to be consistent on an ongoing basis.

8.2.3 Sample Analysis

Sampling and analysis required by these guidelines, are the responsibility of the facility owner or operator.

Submission of duplicate samples to a Ministry of the Enivronment designated laboratory for quality control auditing purposes may be required.

8.2.4 Sample Parameters

The Ministry of the Environment may vary the number of parameters to be analyzed for, or the frequency of analysis commensurate with changes in the waste stream or processing, or the known presence of potentially toxic substances.

8.2.5 Sample Quality Assurance

Sample collection, preservation, and analysis will assure valid and representative results pursuant to a minstry approved quality assurance plan.

8.3 Records and Reporting

Plant owners or operators must, from start-up, record and keep the following information regarding their activities for a two-year period:

- The source, type and quantity of wastes received;

- Process operating information (temperature {see Section 6.2}, oxygen levels, retention time) and any significant operating problems;

- The quantity, by weight and volume of compost and residues produced and the quantity of compost and residues removed from the facility;
- A description of compost distribution/markets; and
- All information and analyses required with copies of laboratory reports and other supporting documentation.

This information is to be made available to the Ministry of the Environment upon request.

8.4 Monitoring Off-site Impacts

The impact of composting operations upon nearby property may require monitoring. The need for monitoring will be reviewed, on a case-by-case basis, by Ministry of the Environment regional staff. Where monitoring needs are identified, monitoring should commence prior to operation of the site to provide background data. The principal concerns are noise, odours, air quality, ground and surface water quality, vectors and the potential for and effects of liquid discharges to municipal sewers.

The effects of transporting materials to and away from the site, are normally accounted for prior to issuance of the Certificate of Approval. However, monitoring to assess if actual traffic volumes and their effects exceed those predictions may also be necessary.

APPENDIX 1

Derivation of Guideline Criteria and List of Reference Documents

The compost quality metals criteria are derived from Ministry of the Environment, *"Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples*, and are identical to the concentrations shown for rural soil.

Total salts and Sodium Absorption Ratio limits are from Table A-2, Ministry of the Environment, *Guidelines for the Decommissioning and Cleanup of Sites in Ontario*.

Mineral content, pH, organic matter content, carbon to nitrogen ratio, moisture content, and water holding capacity are included showing "typical concentrations". It is deemed that their concentrations will be driven and determined by end user markets. The *Interim Guidelines* do not attempt to be inappropriately restrictive by limiting concentrations of these parameters.

PCB concentration based on Canadian Council of Ministers of the Environment guidelines for agricultural soils. Concentrations of inert materials and compost particle size requirements are based on past Ministry of the Environment experience and expectations of raw waste quality, as well as providing guidance in an area where specific market constraints are likely to be more restrictive than concern from an environmental perspective.

There is no single, conclusive or definitive method of quantifying compost stability. For that reason, considerable latitude in selecting stability test is granted proponents, but with the proviso that should such tests not be conducted, then extensive product curing periods must be applied.

Some documents consulted in the preparation of the *Interim Guidelines* include:

Ontario's Guidelines for Sewage Sludge Utilization on Agricultural Lands, Ontario Ministries of Agriculture and Food, Environment, and Health.

Proceedings of a Seminar on Composting of Organic Wastes (October 24, 1984) Ontario Ministry of the Environment, the Pollution Control Association of Ontario and the School of Engineering, University of Guelph.

"Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples Air Resources Branch, Ministry of the Environment.

Guidelines for the Decommissioning and Cleanup of Sites in Ontario Waste Management Branch, Ministry of the Environment.

PCB Guidelines, Canadian Council of Ministers of the Environment

Guidelines for Land Use Surrounding Small and Medium Sized Sewage Treatment Plants, Ministry of the Environment.

Composting - A Literature Study, Waste Management Branch, Ministry of the Environment.

Rule 17-709, "Criteria for the Production and Use of Compost Made from Solid waste", Florida Dept. of Environmental Regulation.

Solid Waste Management Rule 7001.3375, "Final Application Information Requirements for Compost Facilities", Minnesota Pollution Control Agency.

Solid Waste Facilities Sub-Part 360-5: "Composting Facilities", New York State Dept. of Environmental Conservation.

Fertilizers Act and *Memorandum T-4-93*: "Metal Concentrations in Processed Sewage and Byproducts", Agriculture Canada, Food Production and Inspection Branch, Fertilizer Section.

Various Ontario Acts and Regulations have an impact on composting operations. In the *Interim Guidelines*, application of the *Ontario Water Resources Act, Environmental Protection Act*, and *Environmental Assessment Act*, administered by the Ministry of the Environment, is described where appropriate. Other legislation such as the *Consolidated Hearings Act, Ontario Municipal Board Act, Planning Act, Expropriations Act, Conservation Authorities Act* and the federal *Fertilizers Act* may apply in some situations.

In addition, other legislation administered by municipal, provincial or federal agencies may apply, and compliance with the *Interm Guidlines* does not exempt a composting proponent from these. It is likely, however, that use of the guidelines will assist in meeting the legislative requirements of other agencies and help expedite projects.

APPENDIX 2

SITING AND PLANT OPERATING INFORMATION

COMMENT: This Appendix describes information which will likely be required when applying for EPA Part V Approvals.

1.0 Location Maps

1. A *vicinity map* (minimum 1:20,000 MNR Topographic Sheet) showing:

   i) the entire service area of the proposed facility both existing and proposed;

   ii) existing and proposed collection, processing and disposal operations;

   iii) the closest population centres;

   iv) transportation systems including highways, airports and railways.

   v) facility boundaries

   vi) zoning and land use

   vii) residences, commercial/institutional/industrial operations

   viii) surface waters

   ix) access roads, bridges, railroads, airports, historic sites

   x) other existing and proposed man-made or natural features

2. A *site plan* (minimum 1:2,000 MNR Topographic Sheet) with one meter contour intervals showing:

   i) property lines

   ii) existing and proposed soil borings, monitoring wells, drainage, culverts

   iii) buildings and appurtenances, parking areas

iv) fences, gates, roads

v) storage and loading facilities or areas

vi) existing and proposed elevation contours and topography indicating run-off and storm water management facilities

vii) direction of prevailing winds

viii) residences

ix) potable wells, surface water bodies

2.0 Operational Procedures

1. Schedule of operation, showing days and hours that the facility will operate, preparations for daily opening, daily procedures, and procedures followed after closing for the day.

2. Estimated daily traffic to and from the facility, including number of trips by private or public vehicles, routes followed, and quantities of material contained in each vehicle.

3. Description of gate control and incoming material monitoring methods and site security.

4. Procedure for unloading trucks, including frequency, rate and method.

5. Procedures for handling and storing materials for processing, and removal of surplus or non-processible residue.

6. Special precautions or procedures for operation during wind, heavy rain, snow, freezing weather, and other inclement conditions.

7. Finished compost:

   i) a description of the primary markets for the compost;

   ii) method for removal from the site;

   iii) a plan for disposal or other use of compost that cannot meet primary markets due to poor quality or other factors;

iv) description of label or other information means that outlines:

- the type of waste the compost was derived from;
- a list of any restrictions on use;
- recommended application rates.
  (Note that application rates to agricultural land shall not cause the maximum permissible metal content in soil (Column 3 of Table 2 of the Sewage Sludge Utilization Guidelines) to be exceeded. The Sludge and Waste Utilization Committee of the Ministries of Environment and Agriculture and Food should be consulted.)
- analysis as per parameters in Section 7.0 of the *Interim Guidelines*.

3.0 Facility Design Description:

3.1 Process Equipment

1. Process flow diagram(s) for the entire process, showing all major equipment and flow streams. The flow streams must indicate quantity of the material by:
   - wet weight;
   - dry weight; and
   - volumetric basis.
2. The type, capacity and general arrangement of equipment, and associated detention time for the handling, processing and storage, including detailed engineering plans and specifications for the entire facility, including manufacturer's performance data for major equipment;
3. The method of measuring, processing, mixing, and proportioning input materials;
4. A description and sizing (where applicable) of the storage facilities for amendment, bulking agent, raw solid waste, and finished compost;
5. The separation, processing, storage, and ultimate disposal of non-compostable

materials (if applicable);

3.2 Feedstocks:

1. A detailed description of the source, quality and quantity of the solid waste to be composted; including the source, quality and expected quantity of bulking agents or amendments (if applicable); and the expected recycle rate of bulking agent or compost.

2. The description must include:

   - the annual solid waste input (both present and projected)

   - any seasonal variations in the solid waste type and quantity.

3. A description of any additives, including quantity, quality, and frequency of use.

3.3 Operating Conditions:

1. The location of all temperature, oxygen and any other monitoring points, and the frequency of monitoring.

2. A description of how the temperature monitoring and control system will ensure that the facility will meet pathogen reduction limitations as per Section 6.

3. The aeration capacity of the system and the method of supplying air (air injection and/or method of turning or mixing), monitoring oxygen levels, and controlling air flow.

4. If applicable, a description of the air emission control techniques.

5. The length of the composting stabilization period for each stage of composting (if applicable), and the method(s) of measuring stability.

6. Method of controlling inerts (e.g. plastic, glass) in terms of particle size and quantity.

7. A description of methods to collect and control surface water run-off and leachate, including method for treatment or disposal of leachate generated.

Calculations of surface run-off that must be handled at the site should be based on local municipal or conservation authority criteria.

8. Procedures to register and report odour complaints; investigate reasons for odour emissions and remedy the problem by improving equipment and/or operational conditions.

9. Contingency plans detailing corrective or remedial action to be taken in event of:

   - feed or material from the composting process that is off specification
   - equipment breakdown
   - air pollution (odours, noise, dust causing adverse)
   - unacceptable waste delivered to the facility
   - groundwater contamination
   - spills
   - vectors

10. The number of staff and their responsibilities.

11. The names of owners, operators or lessees.

12. For facilities subject to EPA Part V Approvals, posting of financial assurance to cover the cost of removing all raw and processed material from site in the event, for example, of bankruptcy. The level of financial assurance can be identified by reference to Ministry of the Environment Policy 02-03.

APPENDIX 3

OVERVIEW OF THE AEROBIC COMPOSTING PROCESS

Aerobic composting is a biological decomposition process which reduces complex organic matter into more stable chemical compounds with the release of heat, water vapour and carbon dioxide. The released heat can, with proper controls, inactivate pathogens and weed seeds. The major requirements for composting are: proper process and equipment design; temperature and moisture control; adequate oxygen supply; suitable feed and nutrients to maintain the biological process.

In addition to having no active pathogens, compost should be chemically stable, contain low concentrations of contaminants such as heavy metals and hazardous organic chemicals, and have an earthy, non-offensive odour. It should also retain water, have proper pH and salinity levels and contain enough nutrients (N, P, K) to benefit plant growth without having adverse effects on soil.

Composting is a multi-phased process:

Phase I	-	Collection and preparation of the raw material
Phase II	-	High rate biological degradation
Phase III	-	Curing
Phase IV	-	Grading of the final product
Phase V	-	Storage, marketing, transportation and use.

Raw materials with potential for composting are:

- The biodegradable organic fraction of municipal solid waste
- Yard, garden, grass and leaf wastes;
- Agricultural crop residues and animal manures;
- Food processing wastes;
- Forest products and paper production wastes;
- Sludges from sewage treatment plants.

The collection and transportation methods used are an integral part of any composting operation. Source separation of the collected materials greatly reduces contaminants entering the composting process.

Waste pre-treatment to reduce particle size is generally necessary. This can be accomplished using shredders, grinders or hammermills with suitable screens to produce a fine, homogenous material for composting. Hammermills are particularly effective in pulverizing brittle materials into granules instead of splinters or shards. Ferrous metals can be removed by magnets.

GENERIC METHODS OF COMPOSTING

Composting process technologies fall into three main categories. Each category has its own aeration method:

- Windrows (turned or static);
- Aerated static pile; and
- In-vessel.

Turned and Static Windrows

Raw material is stacked into an elongated pile of approximately triangular, cross-section shape.

Windrows are torn down and reconstructed by mechanical turning. The method and frequency of turning is closely related to the nature of the waste, its oxygen demand, moisture content, uniformity of decomposition, structural strength and pathogen inactivation requirements.

In turning, the outside layer of the original windrow becomes the interior of the rebuilt windrow. Multiple turnings lend more assurance that proper composting process conditions are met.

Turning should be done in relatively calm weather, to the greatest extent possible, to minimize off-site effects due to odours or dust.

Static windrows (windrows that are not turned) rely on the natural diffusion of oxygen into the pile, and are unlikely to provide conditions to allow compost to meet this Guideline.

Aerated Static Pile

The aerated static pile method features either forced (injected) air into the composting mass, or drawn (inducted) air through it, or both.

To construct a static pile windrow, a grid of perforated pipe is laid. The grid is connected to a fan and is covered with a layer of bulking agent (e.g. wood chips) or finished compost. The compost pile is then built on the grid. The pile remains intact (i.e. static) throughout the composting period, and is topped with a layer of finished compost to provide insulation to ensure the adequate temperatures for pathogen destruction.

In-Vessel

There are several types of in-vessel systems:

- Rotating drum;
- Horizontal (rectangular/cylindrical) or Vertical (silo)l; and
- Channel.

The objective of these systems is to optimize aeration, temperature and moisture conditions, through improved mixing and automated process control and monitoring systems.

MAJOR OPERATING PARAMETERS

The Stages of Composting

Composting generally occurs in two stages. Initially, the reaction is characterized by high temperature, high oxygen uptake rate, rapid bio-degradation of organic solids, and a high potential for odour production.

As the reaction progresses and waste is consumed, biological activity slows, and as a result the temperature declines. This second stage allows curing, where some residual biological activity occurs. It ends when the residue reaches the required stability. In this stage, temperature, oxygen uptake rate, and potential for odour production are lower.

Stability

There is no exact definition of biological stability with respect to composting. Stability is proportional to retention time, under proper operating conditions, and waste characteristics. The degree of stability required may depend on the end-use of the compost. Complete stability is not readily attainable and not likely desirable as there would be no soil amendment value due to low or non-existent organic content.

On the other hand, compost with a high potential for continuing decomposition can adversely affect crop growth due to toxic effects and nitrogen depletions. There is, therefore, a level of stability which must be met based on end-use of product, and the ability of the compost to be stored or handled with no nuisance effects or conditions occurring.

The relative stability can be determined using indicators such as volatile solids destruction, spontaneous heating, oxygen uptake rates, toxin production, carbon to nitrogen ratio, seed germination and growth tests and redox potential. These tests are not necessarily conclusive or definitive, but do indicate relative stability of compost, compared with the raw feed.

Temperature

The initial ambient temperature of a composting mass quickly reaches thermophilic temperature due to the highly exothermic nature of the biological reaction. Eventually, as biological activity diminishes due to reduction of feed concentrations, the temperature returns to ambient levels during curing.

It is important for the composting mass to attain an optimum temperature between 55° C and 60° C for some time to inactivate pathogens in the material.

Biological activity can continue beyond 60° C, but higher temperatures may start to inhibit biological activity. At temperatures approaching 80° C, all activity will cease. It should be cautioned that substantial drops in temperature can be caused by effects such as oxygen deficiency, low moisture levels, thermal kill of micro-organisms, or toxic effects due to contaminants.

Aeration

Aeration maintains aerobic conditions for the micro-organisms and inhibits the formation of anoxic or anaerobic conditions and resultant odours. Aeration must also satisfy the demands of temperature control, and moisture removal. Determination of air requirements is complex and dependent on both biological and physical variables. Different wastes will exhibit different oxygen demands. Aeration rates are therefore specific to the chemical and physical character of the waste to be composted, and should be determined during the design stage.

Moisture

The micro-organisms require an aqueous, or moist environment to effectively biodegrade wastes. Moisture content, temperature and aeration are closely related. As

moisture evaporates, the reaction slows, the temperature drops below the required level, and the process is inhibited. Subsequent addition of moisture will increase the reaction rate to previous levels and the process will continue.

Carbon to Nitrogen Ratio (C/N)

Control of the C/N ratio is important in optimizing the biological decomposition. The micro-organisms use carbon as a source of energy and both carbon and nitrogen are used for building cell structure. The C/N ratio declines as the decomposition process proceeds. The final compost C/N value affects soil and plants when the compost is applied.

The composting reaction is inhibited at C/N ratios greater than 25:1, due to lack of nitrogen. If high C/N compost is added to soil, soil micro-organisms compete with crops for available nitrogen, thereby reducing growth.

At compost C/N ratios lower than 20:1, the energy source (carbon) is less than needed for conversion of nitrogen into proteins. Such material added to soil would result in the soil microbes removing the excess nitrogen as ammonia, denying it to plants.

High C/N ratios can be lowered by adding nitrogenous waste (e.g. grass clippings, green vegetation, non-ruminant animal manure). A low C/N ratio can be increased by adding low nitrogenous, high carbonaceous waste (e.g. hay, dry leaves, chopped twigs).

Nutrient Content

Carbon(C) and nitrogen(N), as well as phosphorous (P) and potassium (K), are macronutrients for micro-organisms. Micronutrients include cobalt (Co), manganese (Mn), magnesium (Mg), copper (Cu) and calcium (Ca). The latter serves as a buffer that resists changes in pH.

With the exception of nitrogen, most organic wastes contain adequate amounts of nutrients for composting.

Particle Size

Aeration, moisture content, and particle size affect access of micro-organisms to food and nutrients. There is a balance between the desirability of minimal particle size for a more rapid reaction and the need for porosity, created by larger particles, for air, moisture and nutrient flow interaction throughout the pile.

Hydrogen Ion Level (pH)

The optimum pH range for composting is 5.5 - 8.5. Typically, pH levels drop when composting begins, then gradually rise as the reaction progresses.

Salinity

Typically, composts contain about 1% - 2% of soluble salts. These are principally the chlorides and sulphates of alkaline metals. The amount of other acids, including organic acids, depends on the specific process and waste.

When compost is used, some of the salts are taken up by the plants, some remain in the soil and others may leach into the groundwater.

Plants vary in their sensitivity to salt. Excessive levels of salt in soil adversely affect root function and plant growth. Seedlings and newly rooted cuttings are particularly sensitive.

Pathogens

Pathogenic organisms, present in various organic materials, are a potential public health threat to site operators and compost users. Pathogens belong to four main groups: bacteria, viruses, parasites and fungi. In composting, heat is the primary factor in pathogen inactivation.

Thermophilic temperatures must be reached and maintained for an adequate time to inactivate pathogens effectively.

Water Retention

Compost must have the ability to retain water and air in soil to which it is added.

Health and Safety Issues

Health and safety issues are administered through the Ministry of Labour's *Occupational Health and Safety Act*, and its *Regulations for Industrial Establishments*.

In composting facilities, particular care must be placed in conforming with requirements for "confined spaces" in the above regulations, as there is a high potential for oxygen depleted atmospheres in and around composting vessels or masses.

Composting is a biological process analogous to sewage treatment, and regular inoculation of employees may be required, similar to programs for sewage treatment workers. Safeguards against dust inhalation are also important due to the potential for an appreciable endotoxin content in compost plant dust.